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(54) **BALL-JOINT SELECTOR ASSEMBLY HAVING AN INTERNAL SENSOR AND DETENT MECHANISM**

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F16H 59/10 (2006.01)

(52) **U.S. Cl.**
CPC ... ***F16H 59/105*** (2013.01); *F16H 2059/0269* (2013.01)

(58) **Field of Classification Search**
CPC F16H 2059/0269; F16H 59/105
See application file for complete search history.

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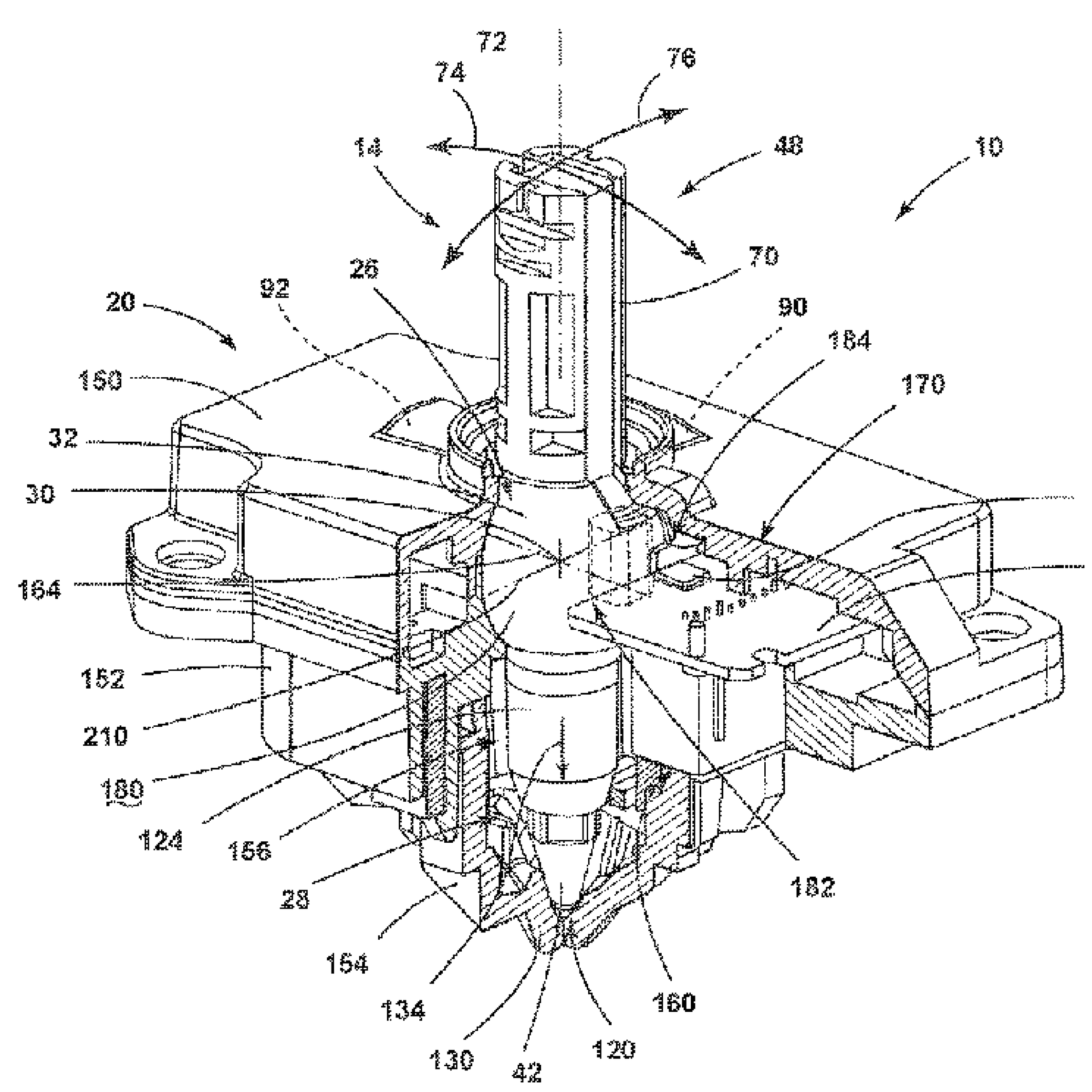
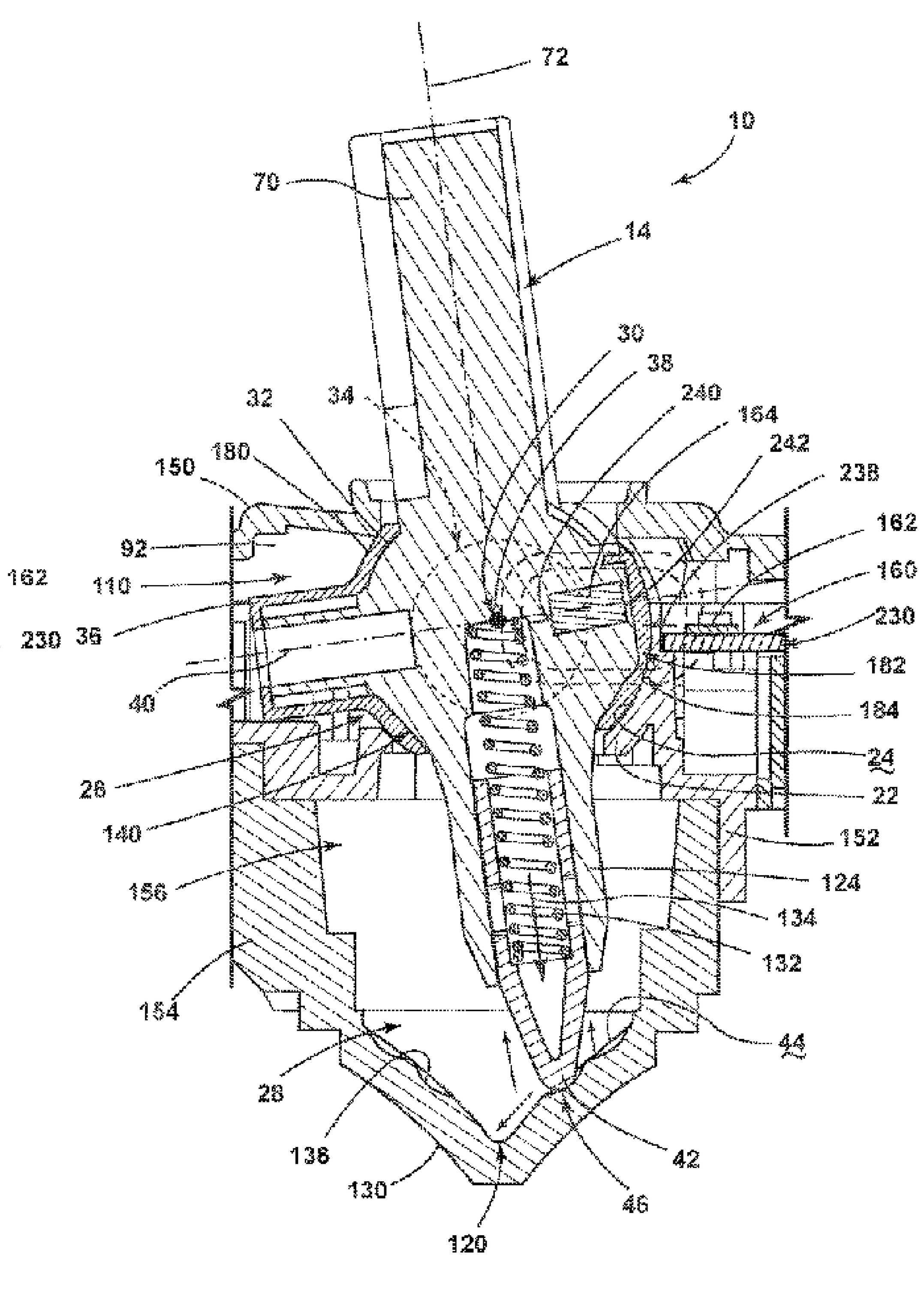
(57) **ABSTRACT**

A selector assembly includes a housing having a spherical cavity and a detent cavity. A positioning sensor is positioned within a sensor cavity and is in communication with the spherical cavity. A selector operates about a center point of the spherical cavity and includes a spheroid member that slidably engages a guide surface of the housing. The spheroid member includes a magnet in electromagnetic communication with the positioning sensor. A first pivot and a second pivot include respective first and second rotational axes that each extend through the center point. A detent pin is biased toward and slidably engages a detent surface of the detent cavity to define a plurality of selector positions of the selector. Operation of the selector within the spherical cavity and along the detent surface defines the plurality of selector positions that are communicated to a controller via the magnet and the positioning sensor.

20 Claims, 10 Drawing Sheets





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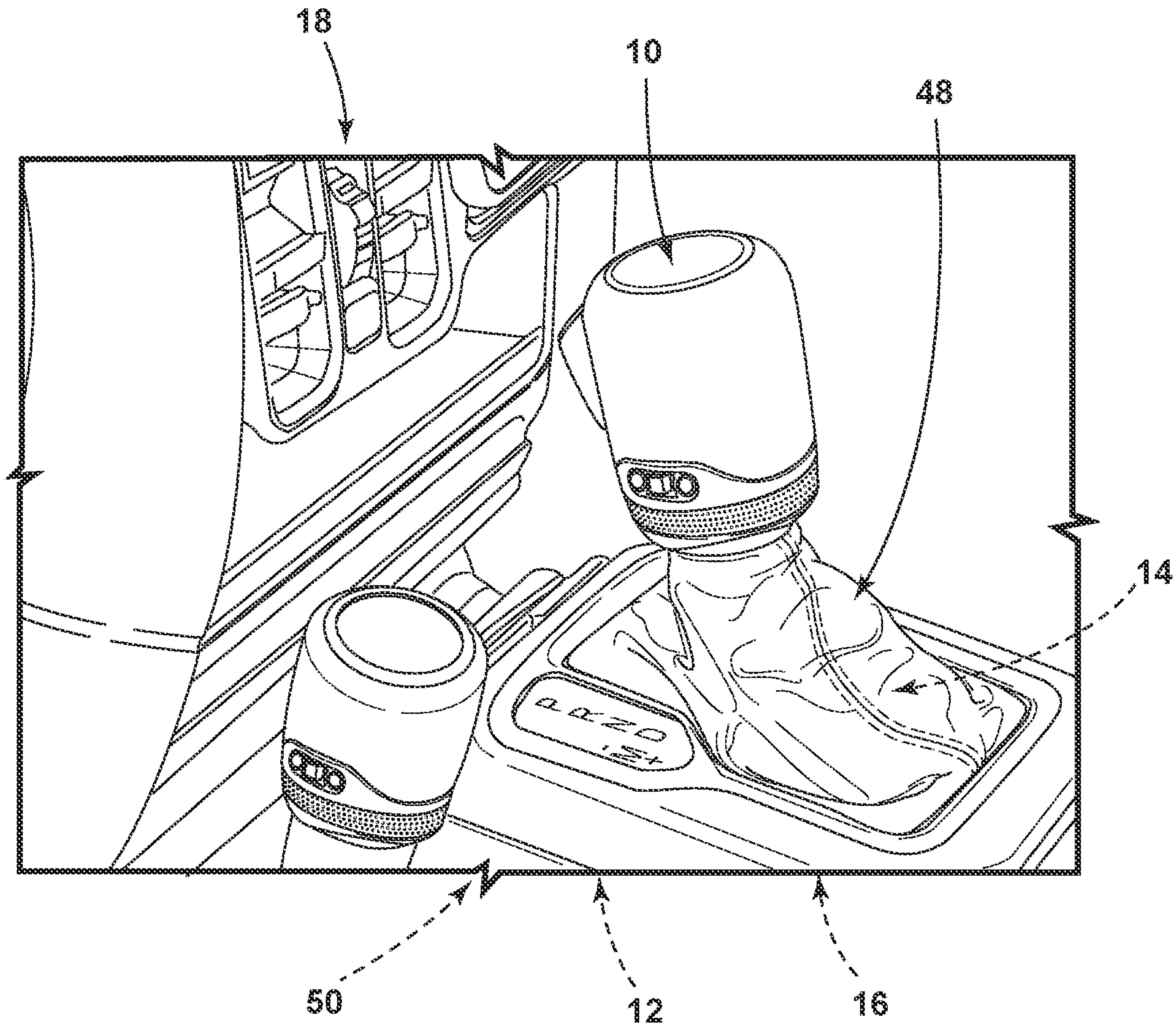


FIG. 1

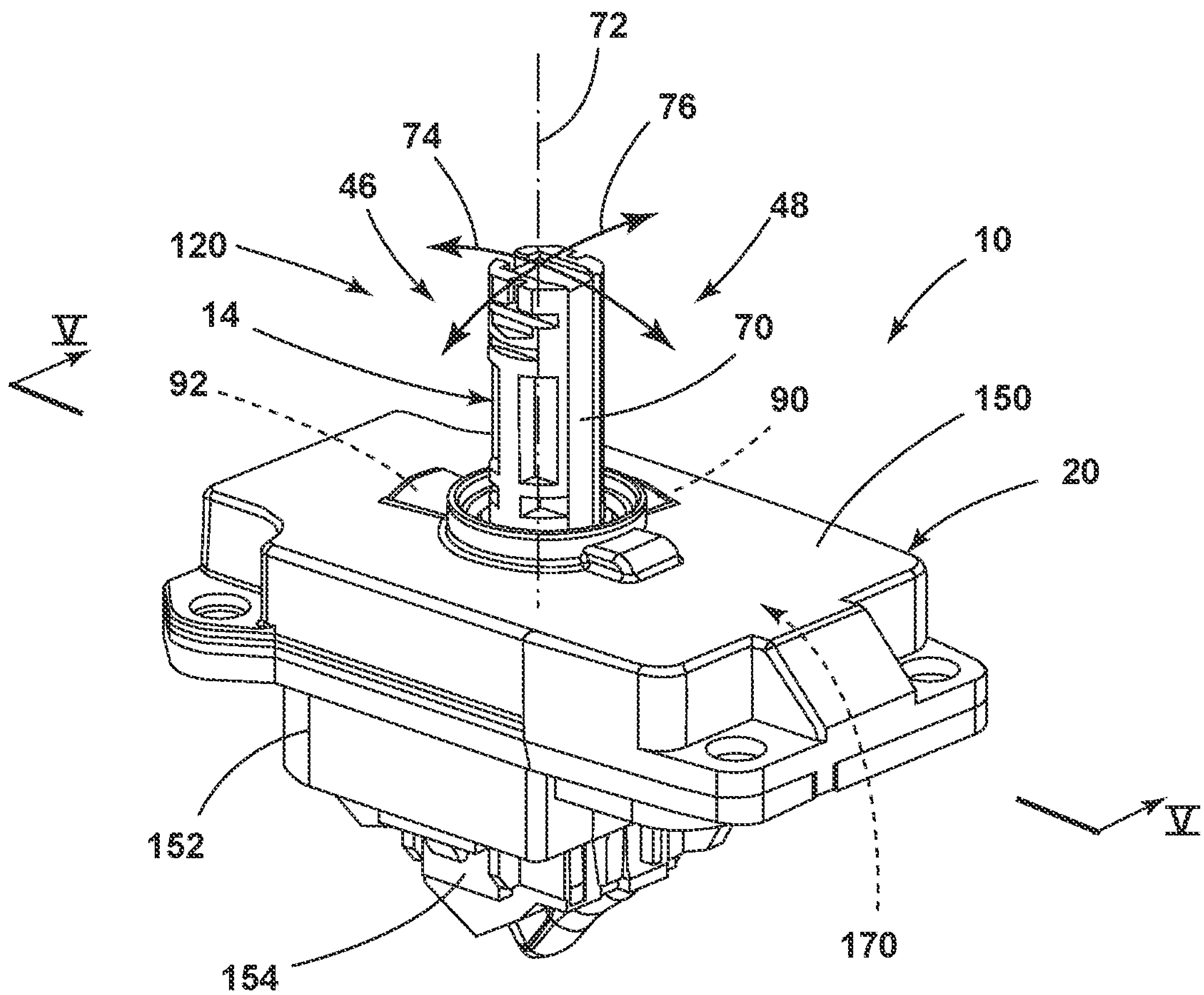
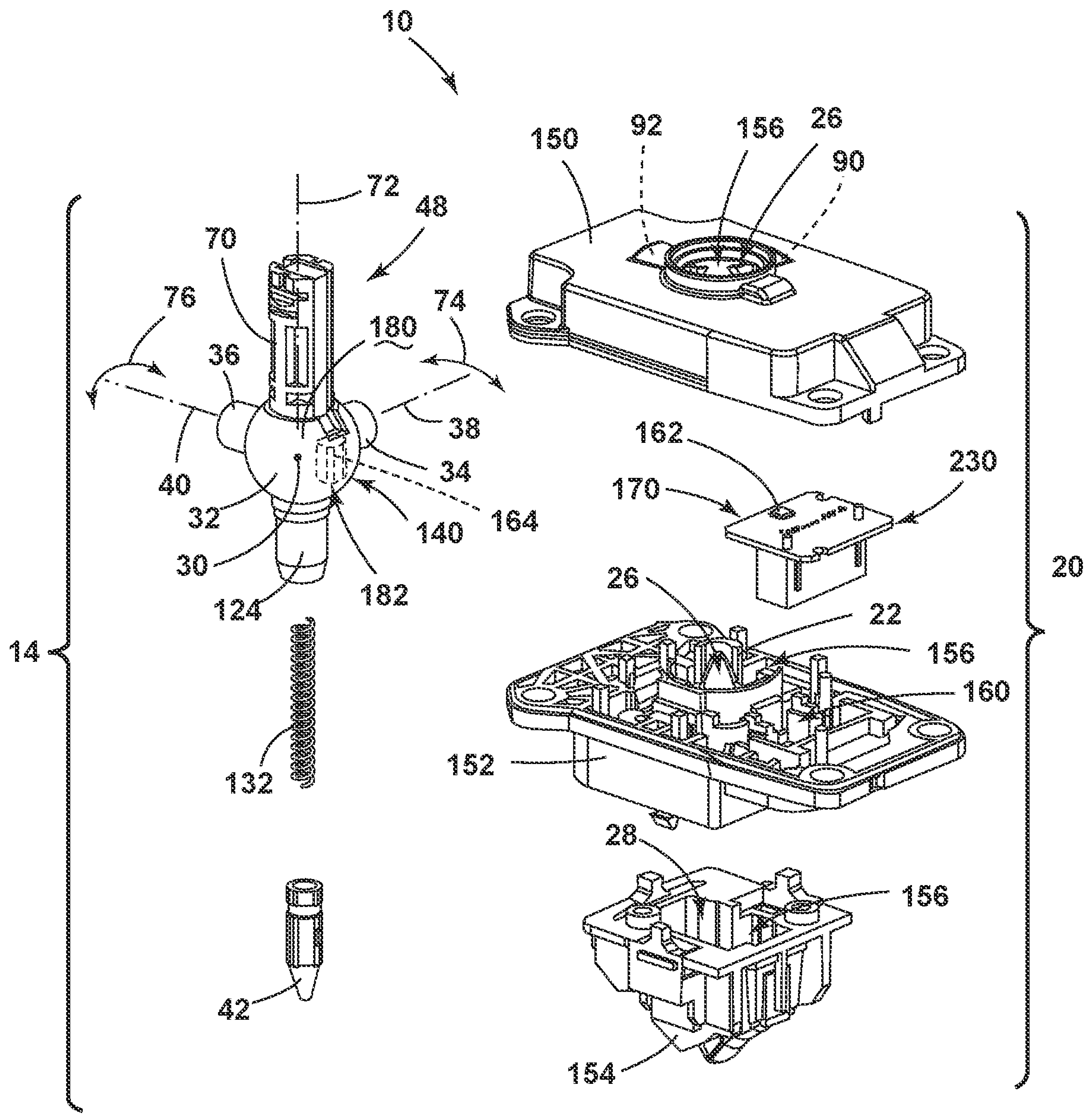


FIG. 2


10
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14
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FIG. 3

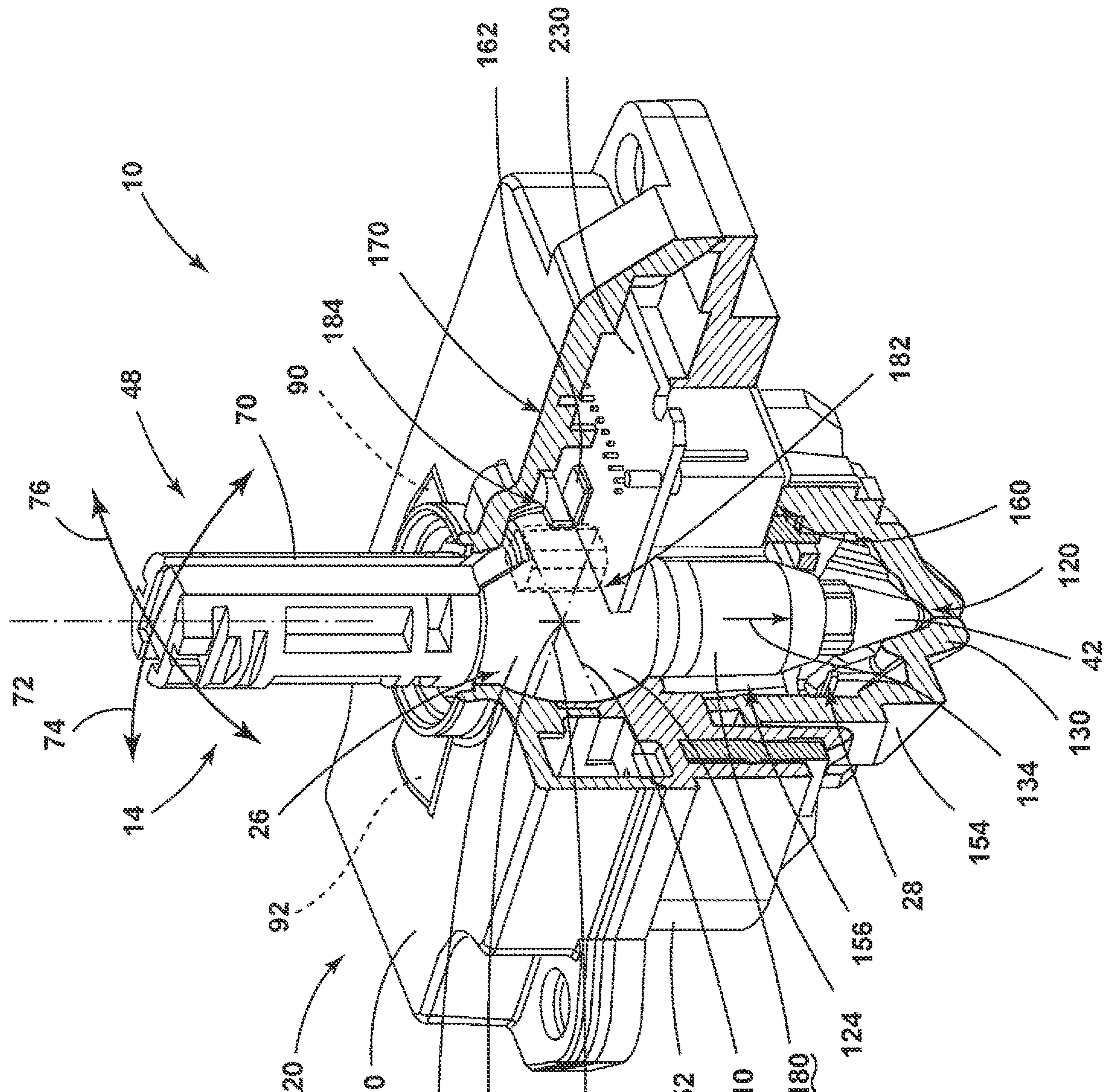

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FIG. 4

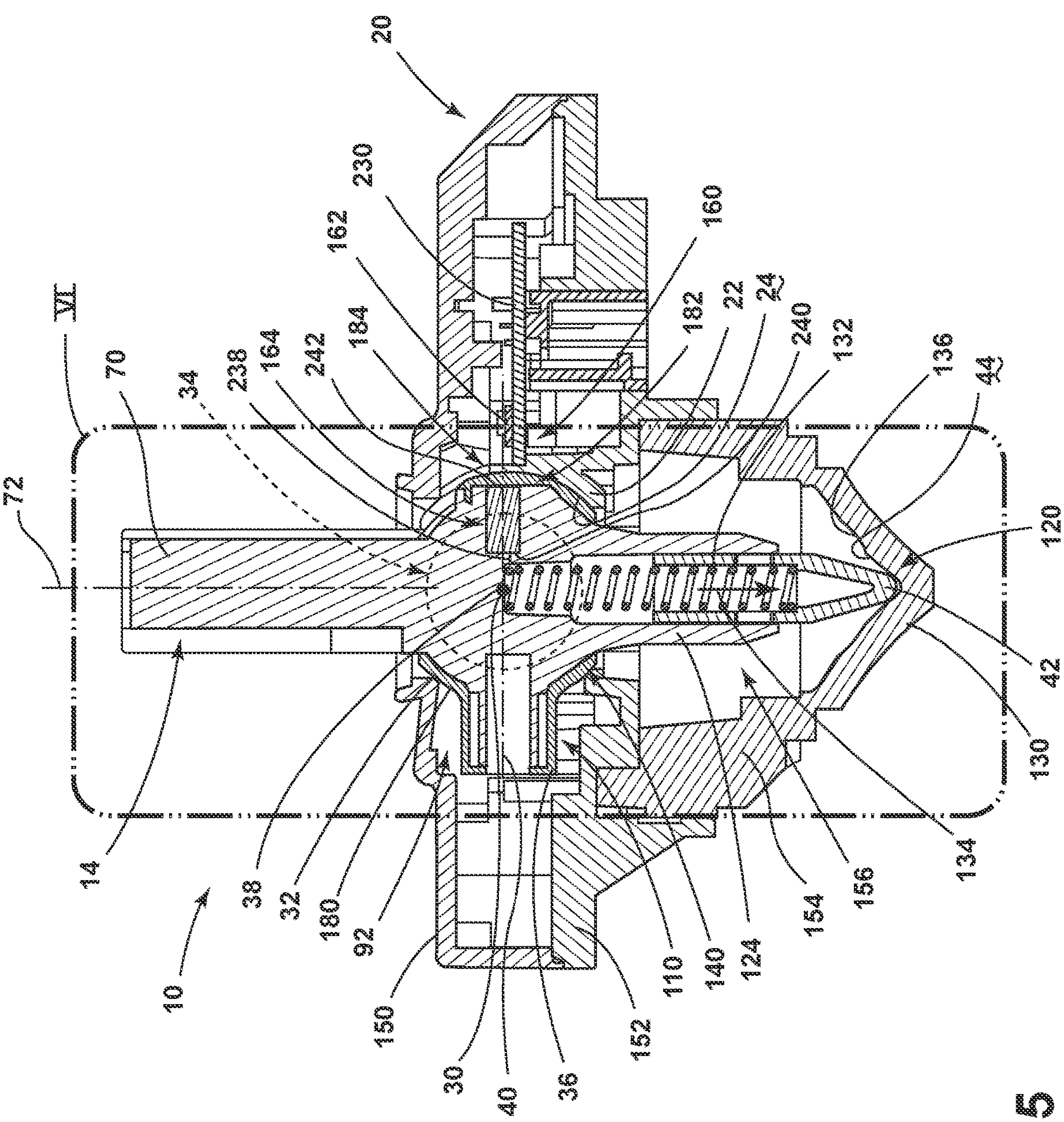
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FIG. 5

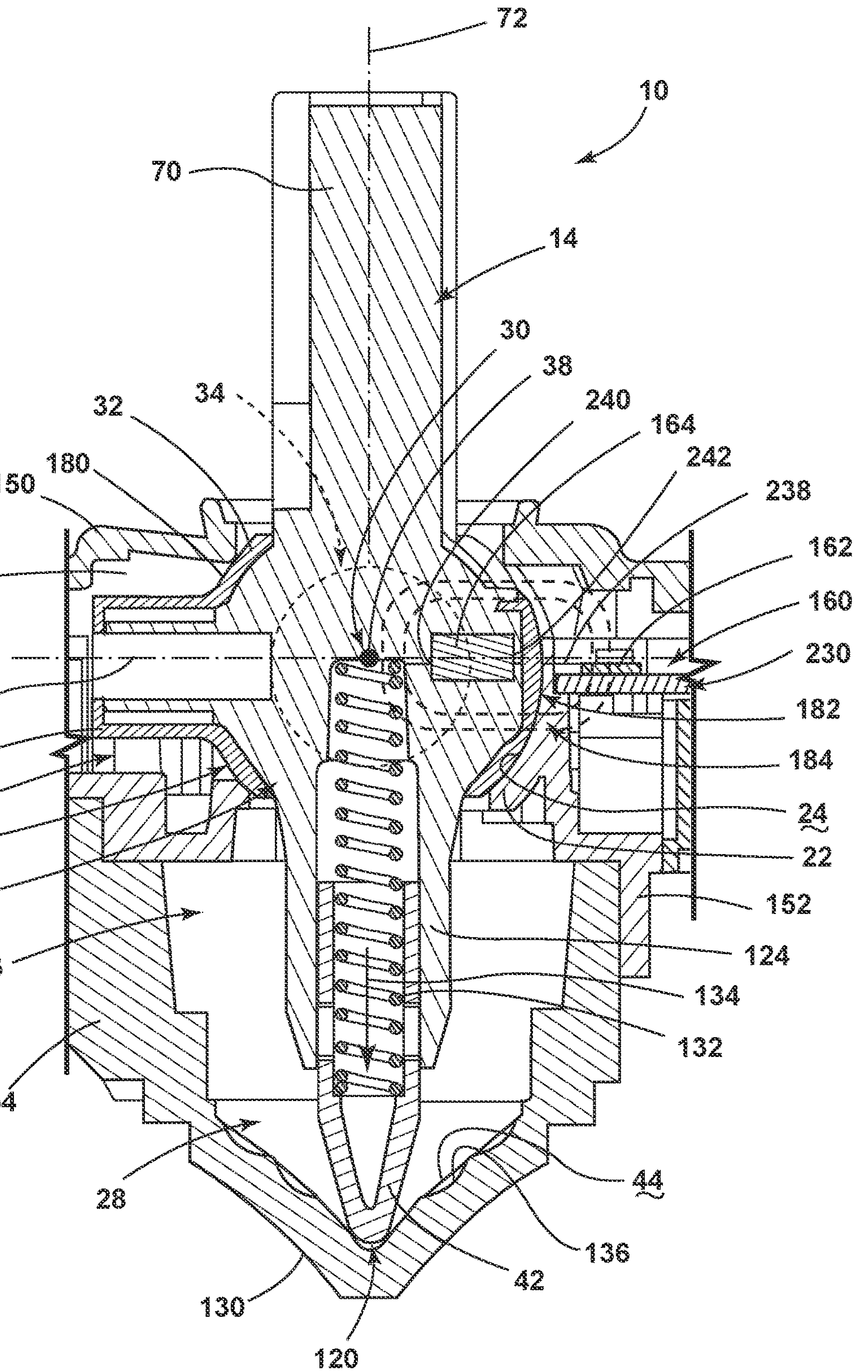
72
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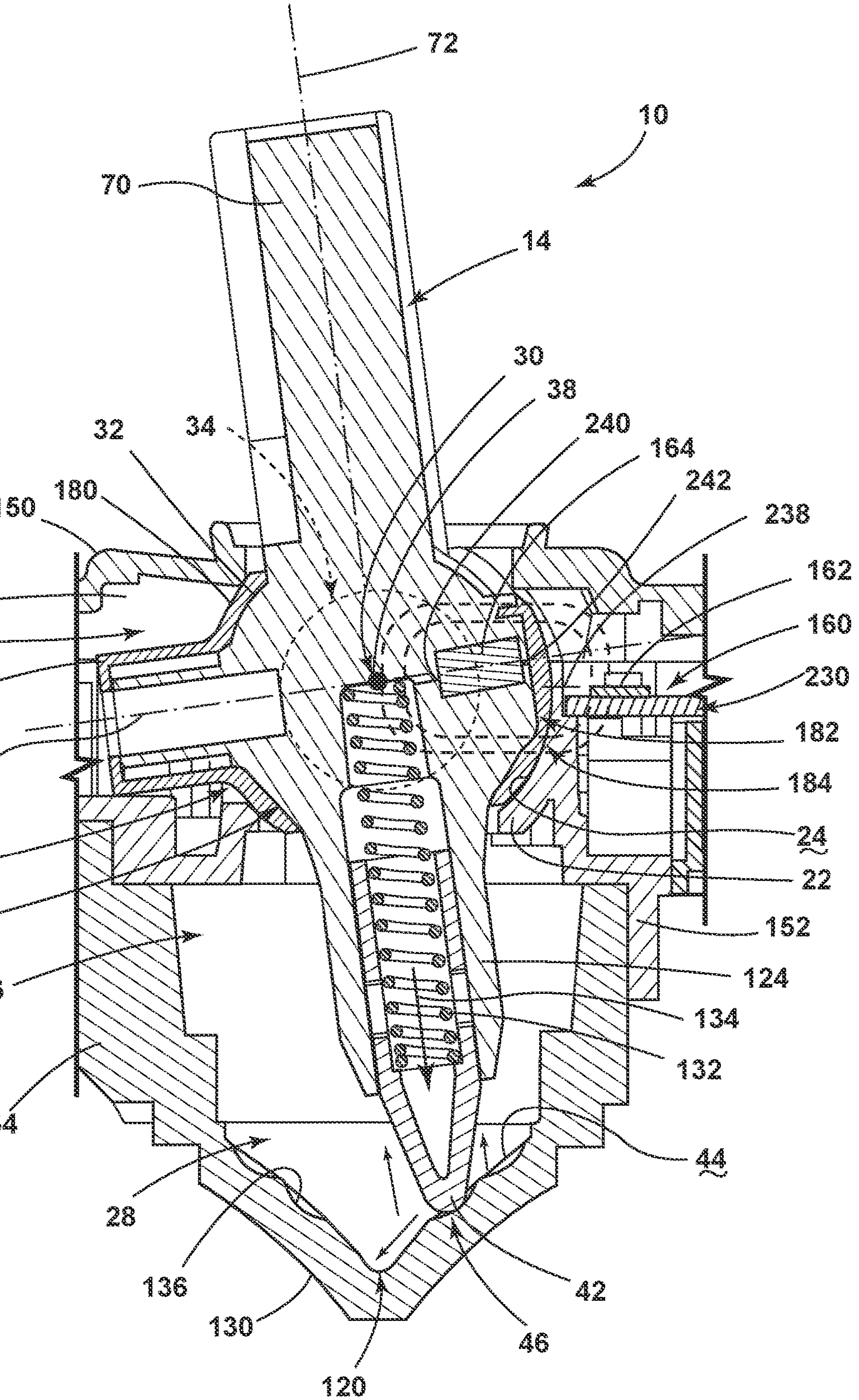
FIG. 6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120

FIG. 7

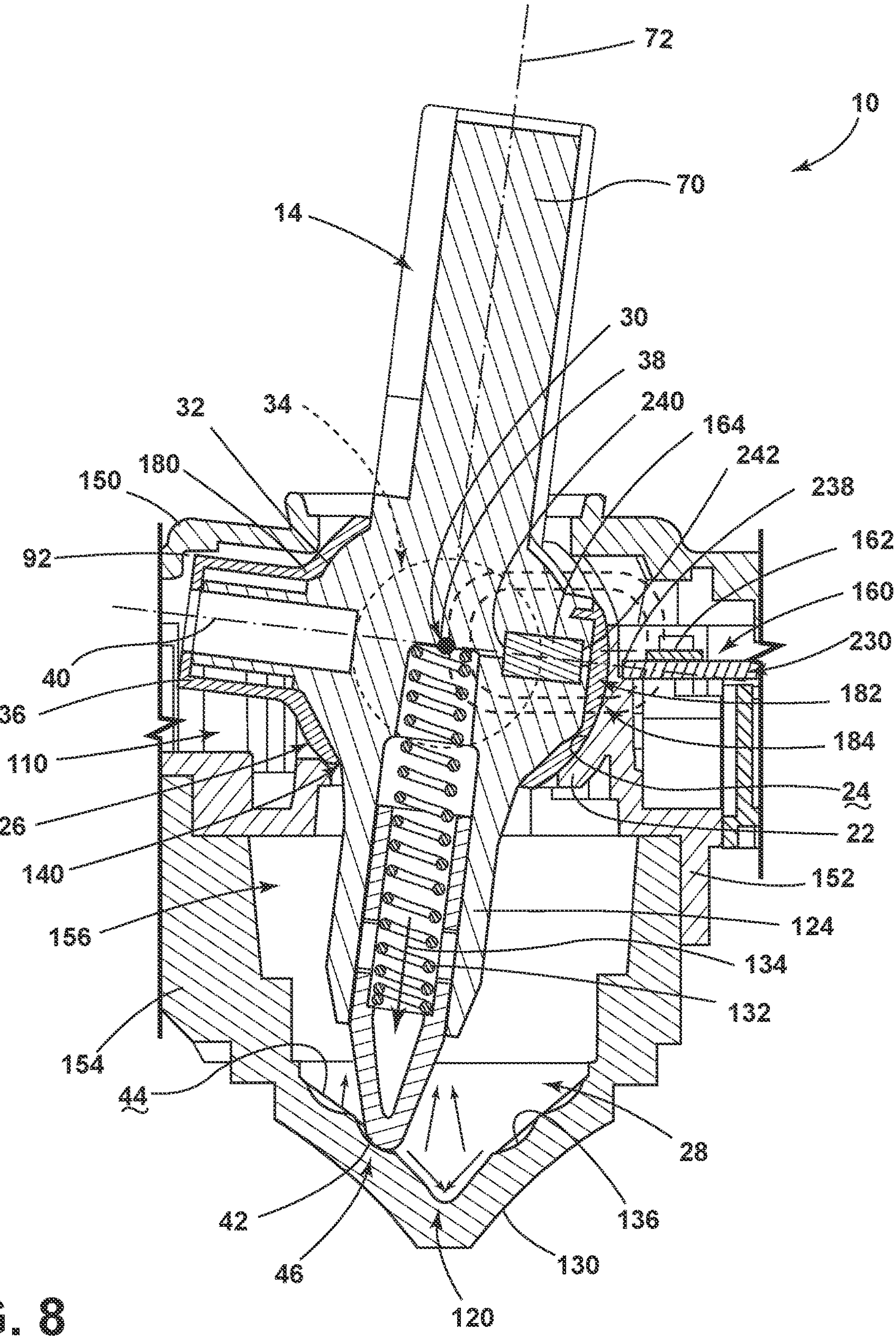

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FIG. 8

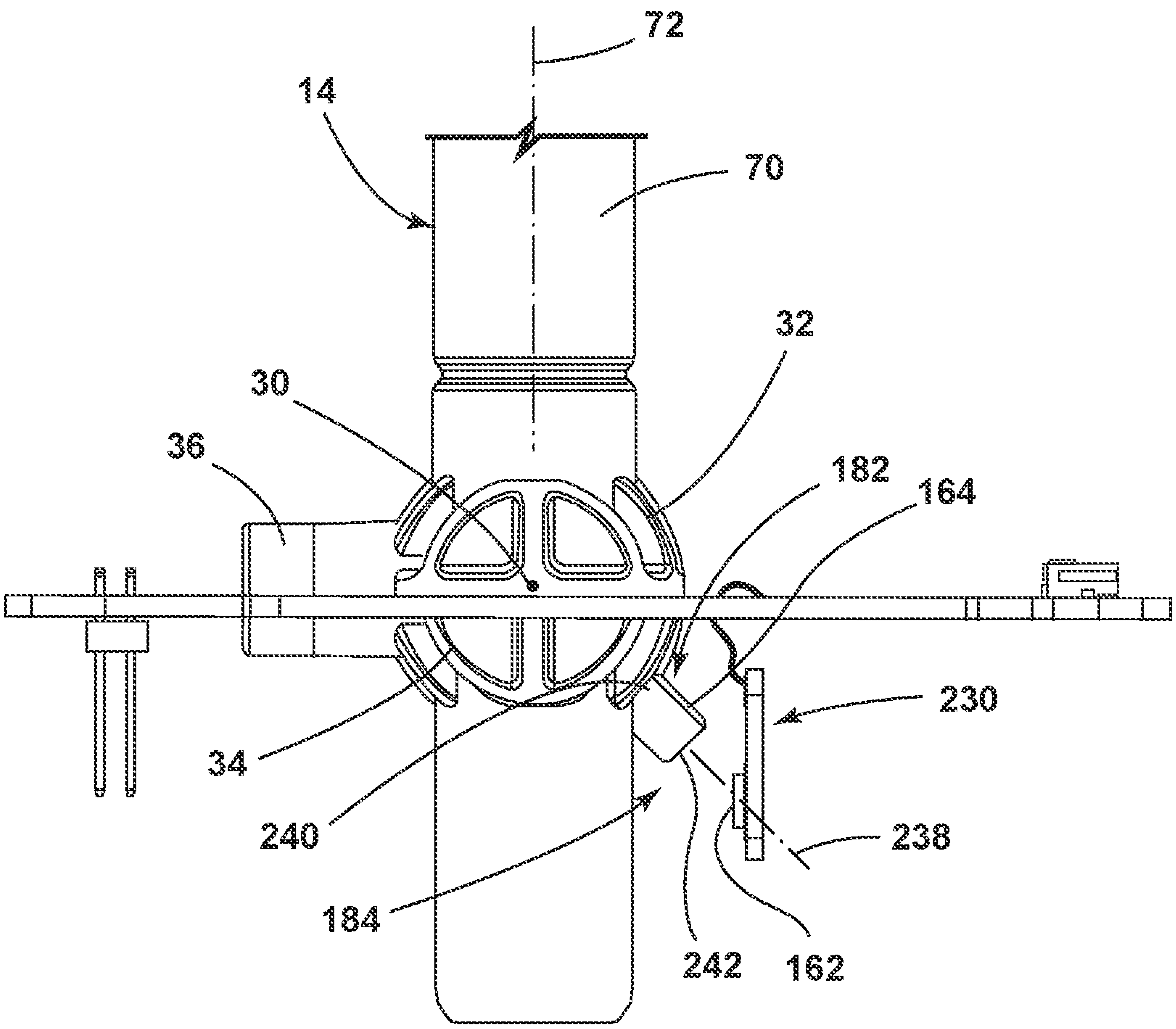

FIG. 9

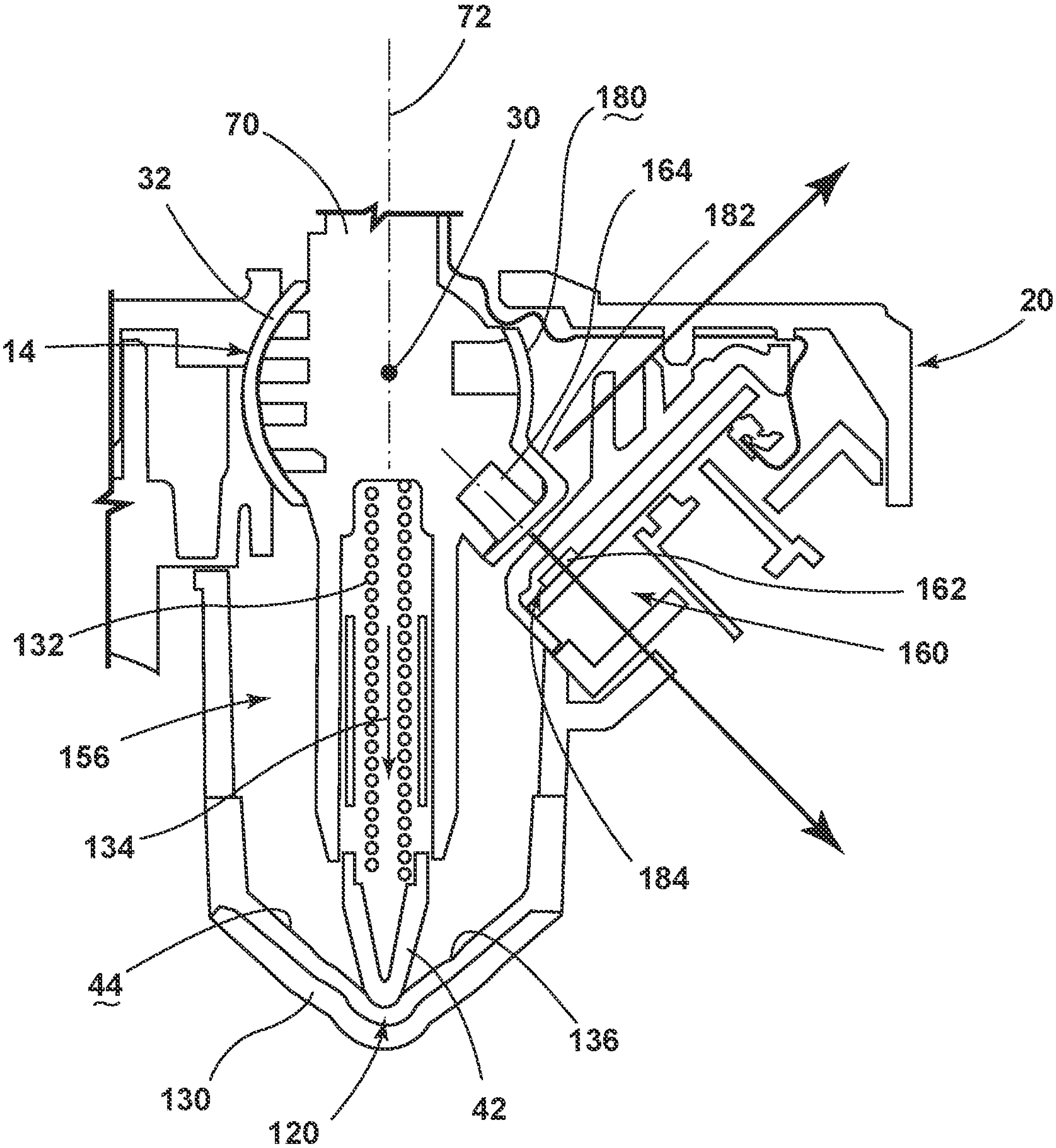
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FIG. 10

BALL-JOINT SELECTOR ASSEMBLY HAVING AN INTERNAL SENSOR AND DETENT MECHANISM

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority to and the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Patent Application No. 63/224,989 filed on Jul. 23, 2021, entitled BALL-JOINT SELECTOR ASSEMBLY HAVING AN INTERNAL SENSOR AND DETENT MECHANISM, the entire disclosure of which is hereby incorporated herein by reference.

FIELD OF THE DEVICE

This device is in the field of selector assemblies, and more specifically, a selector assembly that can be used within a vehicle for modifying at least one electrical or mechanical system of the vehicle, where the selector assembly includes an internal ball joint and detent mechanism that cooperate with an internal sensor assembly to define a plurality of selector positions.

BACKGROUND OF THE DEVICE

Vehicles and other mechanical systems include selectors that can be used for modifying one or more parameters of the particular mechanism. These selectors usually include a user interface that can be manually operated by a user for communicating instructions to the mechanical assembly.

SUMMARY OF THE DISCLOSURE

According to a first aspect of the present disclosure, a selector assembly includes a housing having a spherical cavity and a detent cavity that extends outward from the spherical cavity. A positioning sensor is positioned within a sensor cavity of the housing. The positioning sensor is in communication with the spherical cavity. A selector slidably operates within the housing about a center point of the spherical cavity. The selector includes a spheroid member that is contained within the spherical cavity and slidably engages a guide surface of the housing. The spheroid member includes a magnet that is in electromagnetic communication with the positioning sensor. A first pivot includes a first rotational axis that extends through the center point of the spherical cavity. A second pivot includes a second rotational axis that extends through the center point of the spherical cavity. A detent pin is biased toward a detent surface of the detent cavity and slidably engages the detent surface to define a plurality of selector positions of the selector. Operation of the selector within the spherical cavity and along the detent surface defines the plurality of selector positions that are communicated to a controller via the magnet and the positioning sensor.

According to another aspect, a selector assembly includes a housing having a spherical cavity and a detent cavity that extends outward from the spherical cavity. A Hall sensor is positioned within a sensor cavity of the housing. The Hall sensor is in communication with the spherical cavity. A selector slidably operates within the housing about a center point of the spherical cavity. The selector includes a selector body that includes a spheroid member, a stalk, a detent sleeve, a first pivot and a second pivot. The spheroid member slidably operates within the spherical cavity and about the center point. A magnet is attached to the spheroid member that is in electromagnetic communication with the Hall sensor. A detent pin is disposed within the detent sleeve. The detent pin is biased toward and slidably engages a detent surface of the detent cavity to define a plurality of selector positions of the selector. Operation of the selector within the spherical cavity and along the detent surface defines the plurality of selector positions that are communicated to a controller via the magnet and the Hall sensor. The selector is rotationally fixed with respect to a longitudinal axis that extends through the stalk. The first pivot includes a first rotational axis and the second pivot includes a second rotational axis. The first rotational axis and the second rotational axis extend through the center point.

According to another aspect, a selector assembly includes a housing having a selector cavity that includes a spherical cavity and a detent cavity. A Hall sensor is positioned within a sensor cavity of the housing. The Hall sensor is in communication with the spherical cavity. A selector slidably operates within the selector cavity about a center point of the spherical cavity. The selector includes a spheroid member that is contained within the spherical cavity and slidably engages a guide surface of the housing. The spheroid member includes a magnet that is in electromagnetic communication with the Hall sensor. A stalk extends from the spheroid member and protrudes from the housing. A first pivot includes a first rotational axis that extends through the center point of the spherical cavity. A second pivot includes a second rotational axis that extends through the center point of the spherical cavity. The selector is rotationally fixed with respect to a longitudinal axis that extends through the stalk. A detent sleeve s integral with the spheroid member. A detent pin is disposed within the detent sleeve. The detent pin is biased toward and slidably engages a detent surface of the detent cavity to define a plurality of selector positions of the selector. Operation of the selector within the spherical cavity and along the detent surface defines the plurality of selector positions that are communicated to a controller via the magnet and the Hall sensor.

These and other aspects, objects, and features of the present disclosure will be understood and appreciated by those skilled in the art upon studying the following specification, claims, and appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. **1** is a perspective view of a shifter assembly that incorporates an exemplary aspect of the ball-joint selector;

FIG. **2** is a perspective view of the ball-joint selector;

FIG. **3** is an exploded perspective view of the ball-joint selector of FIG. **2**;

FIG. **4** is a cut-away perspective view of the ball-joint selector of FIG. **2** and showing placement of the spheroid member of the ball-joint selector within the spherical cavity of the housing;

FIG. **5** is a cross-sectional view of the ball-joint selector of FIG. **2** take along line V-V;

FIG. **6** is an exploded cross-sectional view of the ball-joint selector of FIG. **5** taken at area VI;

FIG. **7** is a cross-sectional view of the ball-joint selector of FIG. **6** and showing the ball-joint selector in an alternative selector position;

FIG. **8** is a cross-sectional view of the ball-joint selector of FIG. **6** and showing the ball-joint selector in an alternative selector position;

FIG. **9** is a schematic elevational view of an aspect of the ball-joint selector and cooperating sensor assembly; and

FIG. **10** is a schematic cross-sectional view of an aspect of the ball-joint selector and cooperating sensor assembly.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As required, detailed embodiments of the present disclosure are disclosed herein; however, it is to be understood that the disclosed embodiments are merely exemplary of the invention that may be embodied in various and alternative forms. The figures are not necessarily to a detailed design; some schematics may be exaggerated or minimized to show function overview. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a representative basis for teaching one skilled in the art to variously employ the present invention.

For purposes of description herein, the terms "upper," "lower," "right," "left," "rear," "front," "vertical," "horizontal," and derivatives thereof shall relate to the concepts as oriented in FIG. **1**. However, it is to be understood that the concepts may assume various alternative orientations, except where expressly specified to the contrary. It is also to be understood that the specific devices and processes illustrated in the attached drawings, and described in the following specification are simply exemplary embodiments of the inventive concepts defined in the appended claims. Hence, specific dimensions and other physical characteristics relating to the embodiments disclosed herein are not to be considered as limiting, unless the claims expressly state otherwise.

The present illustrated embodiments reside primarily in combinations of method steps and apparatus components related to a ball-joint selector assembly that includes a spheroid member that slidably operates within a spherical cavity to contain the movement of the selector through a defined range of selector positions. Accordingly, the apparatus components and method steps have been represented, where appropriate, by conventional symbols in the drawings, showing only those specific details that are pertinent to understanding the embodiments of the present disclosure so as not to obscure the disclosure with details that will be readily apparent to those of ordinary skill in the art having the benefit of the description herein. Further, like numerals in the description and drawings represent like elements.

As used herein, the term "and/or," when used in a list of two or more items, means that any one of the listed items can be employed by itself, or any combination of two or more of the listed items, can be employed. For example, if a composition is described as containing components A, B, and/or C, the composition can contain A alone; B alone; C alone; A and B in combination; A and C in combination; B and C in combination; or A, B, and C in combination.

In this document, relational terms, such as first and second, top and bottom, and the like, are used solely to distinguish one entity or action from another entity or action, without necessarily requiring or implying any actual such relationship or order between such entities or actions. The terms "comprises," "comprising," or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus. An element proceeded by "comprises . . . a" does not, without more constraints, preclude the existence of additional identical elements in the process, method, article, or apparatus that comprises the element.

As used herein, the term "about" means that amounts, sizes, formulations, parameters, and other quantities and characteristics are not and need not be exact, but may be approximate and/or larger or smaller, as desired, reflecting tolerances, conversion factors, rounding off, measurement error and the like, and other factors known to those of skill in the art. When the term "about" is used in describing a value or an end-point of a range, the disclosure should be understood to include the specific value or end-point referred to. Whether or not a numerical value or end-point of a range in the specification recites "about," the numerical value or end-point of a range is intended to include two embodiments: one modified by "about," and one not modified by "about." It will be further understood that the end-points of each of the ranges are significant both in relation to the other end-point, and independently of the other end-point.

The terms "substantial," "substantially," and variations thereof as used herein are intended to note that a described feature is equal or approximately equal to a value or description. For example, a "substantially planar" surface is intended to denote a surface that is planar or approximately planar. Moreover, "substantially" is intended to denote that two values are equal or approximately equal. In some embodiments, "substantially" may denote values within about 10% of each other, such as within about 5% of each other, or within about 2% of each other.

As used herein the terms "the," "a," or "an," mean "at least one," and should not be limited to "only one" unless explicitly indicated to the contrary. Thus, for example, reference to "a component" includes embodiments having two or more such components unless the context clearly indicates otherwise.

Referring now to FIGS. **1-8**, reference numeral **10** generally refers to a selector assembly that is incorporated within any one of various dedicated mechanical assemblies **12**. The selector assembly **10** includes a ball-joint selector **14** that is used to provide instructions to the mechanical assembly **12**, typically via a digital interface. The ball-joint selector **14** can be incorporated within a shift-by-wire mechanism **16** for a vehicle **18** that is used to control a transmission for the vehicle **18**. According to various aspects of the device, the selector assembly **10** includes a housing **20** having internal supports **22** that extend into a guide surface **24**. The guide surface **24** partially defines a spherical cavity **26**. The housing **20** also includes a detent cavity **28** that extends outward from the spherical cavity **26**. Through this configuration, the spherical cavity **26** and the detent cavity **28** define a single continuous selector cavity **156** within the housing **20**. The ball-joint selector **14** slidably operates within the housing **20** and about a center point **30** of the spherical cavity **26**. The ball-joint selector **14** includes a spheroid member **32** that is contained within the spherical cavity **26** and slidably engages the guide surface **24** of the spherical cavity **26**.

Referring again to FIGS. **1-8**, the ball-joint selector **14** also includes at least one stability feature that provides for selective and alternative rotation of the ball-joint selector **14** about a first rotational axis **38** and a second rotational axis **40**. The at least one stability feature also prevents rotation of the ball-joint selector **14** about a longitudinal axis **72** of the ball-joint selector **14**. The at least one stability feature can include at least one of a first pivot **34** and a second pivot **36**. The first pivot **34** includes a first rotational axis **38** that extends through the center point **30** of the spherical cavity **26**. The second pivot **36** includes a second rotational axis **40** that also extends through the center point **30** of the spherical cavity **26**. During operation of the ball-joint selector **14**, the first and second rotational axes **38**, **40** maintain their position through the center point **30** of the spherical cavity **26**. Through this configuration, operation of the ball-joint selector **14** within the housing **20** maintains the spheroid member **32** within the spherical cavity **26** of the housing **20**. The ball-joint selector **14** also includes a detent pin **42** that is biased toward the detent surface **44** within the detent cavity **28**. The detent pin **42** slidably engages the detent surface **44** to define a plurality of selector positions **46** of the ball-joint selector **14**. The ball-joint selector **14** and the housing **20** define a user interface **48** that is in communication with a controller **50**. Operation of the ball-joint selector **14** within the spherical cavity **26** and along the detent surface **44** defines the plurality of selector positions **46**. These selector positions **46** are communicated to the controller **50** for operating the dedicated mechanical assembly **12**. This communication of selector positions **46** can be communicated to the user via haptic feedback, visual feedback, auditory feedback, combinations thereof and other forms of feedback.

According to the various aspects of the device, the ball-joint selector **14** includes a stalk **70** that defines the longitudinal axis **72** that extends through the ball-joint selector **14**. When the ball-joint selector **14** is disposed within the spherical cavity **26** of the housing **20**, it is contemplated that the ball-joint selector **14** is in a rotationally fixed position with respect to the longitudinal axis **72** of the stalk **70**. Accordingly, operation of the stalk **70** can be performed by rotating the ball-joint selector **14** about the center point **30** of the spherical cavity **26** in fore-aft directions **74** as well as left-right directions **76**. These manipulations of the ball-joint selector **14** occur about the first and second rotational axes **38**, **40** of the first and second pivots **34**, **36**. Accordingly, the movement of the ball-joint selector **14** is typically confined to movements in the fore-aft direction **74** about the first rotational axis **38** and left-right direction **76** about the second rotational axis **40**, alternatively. As described herein, the rotationally fixed position of the ball-joint selector **14** with respect to the longitudinal axis **72** of the ball-joint selector **14** can be achieved through the stability feature that can include only one of either the first pivot **34** or the second pivot **36**. At the same time, the stability feature allows for selective and alternative rotation of the ball-joint selector **14** about the first rotational axis **38** and the second rotational axis **40**.

Referring again to FIGS. **4-8**, the housing **20** can include one or both of a first pivot cavity **90** and a second pivot cavity **92** that corresponds to the structure of the stability feature. As discussed herein, the stability feature can include only one or both of the first and second pivots **34**, **36**.

In certain aspects of the device, the ball-joint selector **14** includes a single and continuous member. This single continuous member can be in the form of a single selector body **140** that includes the spheroid member **32**, the detent sleeve **124**, the first pivot **34**, the second pivot **36**, and, where applicable, the stalk **70**. In such an aspect of the device, these components can be a single integral piece formed as the selector body **140**. Accordingly, the selector body **140** forms a unitary piece that operates within the continuous selector cavity **156**.

It is contemplated that the first pivot **34** of the ball-joint selector **14** is defined by a boss that extends into the first pivot cavity **90**. The ball-joint selector **14** also includes a second pivot **36** in the form of a separate boss that extends into the second pivot cavity **92**. Utilizing at least one of the first and second pivots **34**, **36**, a rotationally fixed position of the ball-joint selector **14**, with respect to the longitudinal axis **72** of the stalk **70**, can be maintained within the spherical cavity **26** of the housing **20**.

Referring now to FIGS. **6-8**, as the ball-joint selector **14** is manipulated about the center point **30** of the spherical cavity **26**, the first and/or second pivots **34**, **36** of the ball-joint selector **14** are manipulated within the first and/or second pivot cavities **90**, **92**, respectively. These first and second pivot cavities **90**, **92** provide a clearance space **110** around each of the respective first and second pivots **34**, **36** of the ball-joint selector **14**. These clearance spaces **110** provide for rotation of the ball-joint selector **14** about the center point **30** of the spherical cavity **26** as well as, alternatively, about one of the first and second rotational axes **38**, **40**. In addition, as exemplified in FIG. **6**, it is contemplated that the first and second pivots **34**, **36** can engage the housing **20** to assist in maintaining the rotational position of the ball-joint selector **14** with respect to the longitudinal axis **72** of the stalk **70**. Each of the first and second pivots **34**, **36** is afforded movement through a single plane as well as about the respective first and second rotational axes **38**, **40**. This configuration maintains the ball-joint selector **14** in the rotationally fixed position with respect the longitudinal axis **72** of the stalk **70**. The first and second pivots **34**, **36**, and the planes that they operate through, are generally perpendicular with one another to produce the movements in the fore-aft direction **74** and the left-right direction **76**.

Referring again to FIGS. **6-9**, where only one of the first pivot **34** and the second pivot **36** are included in the ball-joint selector **14**, only one of the first and second pivot cavities **90**, **92** are included as part of the stability feature. In such an aspect of the device, such as where the first pivot **34** is excluded from the ball-joint selector **14**, only the second pivot cavity **92** is included. When the ball-joint selector **14** is rotated about the first rotational axis **38**, the second pivot **36** rotates within the clearance space **110** of the second pivot cavity **92**. This isolated rotation of the ball-joint selector **14** about the first rotational axis **38** also prevents rotation of the ball-joint selector **14** about the second rotational axis **40** and about the longitudinal axis **72**. Alternatively, when the ball-joint selector **14** is rotated about the second rotational axis **40**, the second pivot **36** is held in a stable position within the second pivot cavity **92** through one or more detent features. In this manner, the ball-joint selector **14** is maintained in a position that allows for an isolated operation of the ball-joint selector **14** about the second rotational axis **40** and not about the first rotational axis **38** or about the longitudinal axis **72**.

In certain aspects of the device, the first and/or second pivot cavities **90**, **92** can each include a generally hourglass-shaped configuration to allow for the combined rotational movements of the first and second pivots **34**, **36** when the ball-joint selector **14** is moved in a diagonal motion that includes a fore-aft component and a left-right component.

Typically, the ball-joint selector **14** is configured to be limited to movement in the fore-aft direction **74** and left-right direction **76**, alternatively. In such an aspect of the device, the first and second pivot cavities **90**, **92** have a width that is substantially similar to the first and second pivots **34**, **36** of the ball-joint selector **14**. Through this configuration, when the ball-joint selector **14** is operated about the first rotational axis **38**, the second pivot **36** moves within a second pivot cavity **92**. Conversely, when the ball-joint selector **14** is moved about the second rotational axis **40**, the first pivot **34** moves within the first pivot cavity **90**.

As exemplified in FIGS. **4-8**, operation of the ball-joint selector **14** occurs about the center point **30** of the spherical cavity **26** and about one of the first and second rotational axes **38**, **40**. The ball-joint selector **14** is biased toward a consistent and repeatable home position **120**, as described herein. It is also contemplated that the ball-joint selector **14** can be selectively and alternatively held in place through a series of selectable positions. In such an aspect of the device, such as a gear selector for a vehicle transmission, the ball-joint selector **14** can be held indefinitely within a series of stable positions. Accordingly, various communications between the ball-joint selector **14** and the housing **20** can be maintained in a consistent configuration for the communication of instructions from the user, through the ball-joint selector **14** and to the controller **50** for operating the mechanical assembly **12**.

Referring again to FIGS. **3-8**, the detent surface **44** defines the home position **120** within a base **130** of the detent surface **44**. Additionally, a detent sleeve **124** extends from a portion of the spheroid member **32** to house a detent spring **132**. A detent spring **132** biases the detent pin **42** towards the detent surface **44**. In this manner, the detent spring **132** generates an outward biasing force **134** that, in turn, biases the detent pin **42** and the ball-joint selector **14** towards this home position **120**, or one of the plurality of stable selector positions **46**. The detent surface **44** can include any one of various surface geometries that form detent patterns. These detent patterns interact with the detent pin **42** and the detent spring **132** to temporarily or indefinitely retain the ball-joint selector **14** in a corresponding selector position **46**.

The surface geometry of the detent surface **44** can include any one of various detent depressions **136** that are positioned eccentric to the home position **120** (or the series of selectable stable positions) to cooperate with the detent pin **42**. These depressions **136** are used to define any one of various selector positions **46** of the ball-joint selector **14**. It is also contemplated that the surface geometry of the detent surface **44** can include one or more detent rings that define concentric depressions **136** that extend around the home position **120** or around the stable selector positions **46**. When the ball-joint selector **14** is manipulated in any direction about the center point **30** of the spherical cavity **26**, the ball-joint selector **14** is moved into a certain portion of the detent ring or one of the detent depressions **136** of the detent surface **44**. These depressions **136** temporarily retain the detent pin **42** to provide a haptic or tactile feedback to the user that a particular selected position has been achieved. The detent ring is configured to be sufficiently shallow to temporarily retain the detent pin **42**, but also release the detent pin **42** after a short period of time so that the ball-joint selector **14** can be returned to the home position **120** or one of the stable selector positions **46**. The return of the ball-joint selector **14** to the home position **120** or the stable selector positions **46** is achieved via interaction between the detent pin **42**, the detent spring **132** and the detent surface **44** of the housing **20**. As discussed herein, the detent pin **42** is biased in an outward direction. This biasing force **134** exerted by the detent spring **132** serves to bias the ball-joint selector **14** toward the home position **120** or the stable selector positions **46** with respect to the detent surface **44**.

In certain aspects of the device, the detent surface **44** includes depressions **136** that extend around the home position **120** or around the stable selector positions **46**. In addition, the depressions **136** or other surface geometries can extend outward from the home position **120** or the stable selector positions **46** to define an outward progression of depressions **136**. Through this configuration, the ball-joint selector **14** can be moved into a first layer depression **136** that is proximate the home position **120** or the stable selector positions **46**. The ball-joint selector **14** can be moved farther away from the home position **120** or the stable selector positions **46** to engage progressively outward depressions **136** that are along the same path of travel. Each of these depressions **136** or surface geometries of the detent surface **44** correspond to particular selector positions **46**.

Referring again to FIGS. **6-8**, the various guide surfaces **24** of the housing **20** cooperate to define the spherical cavity **26**. These guide surfaces **24** define touch points where the spheroid member **32** of the ball-joint selector **14** slidably engages the guide surface **24** of the spherical cavity **26**. These touch points are generally maintained during operation of the ball-joint selector **14** with respect to the spherical cavity **26** and the detent surface **44**. This configuration maintains the ball-joint selector **14** in a consistent position that is in alignment with the center point **30** of the spherical cavity **26**. Accordingly, each of the movements of the ball-joint selector **14** occur about this center point **30**.

Referring again to FIGS. **1-8**, the ball-joint selector **14** can include the ball-joint selector **14** that cooperates with the detent surface **44** to achieve any one of a variety of selector positions **46**. It is also contemplated that the ball-joint selector **14** can include a separate rotational mechanism that can cooperate with the various selector positions **46** to provide an additional functionality of the user interface **48**. By way of example, and not limitation, when a user moves the ball-joint selector **14** to a particular selector position **46**, that selection can be used to activate a separate rotational interface that is attached to, or in communication with, the ball-joint selector **14**. The rotational selector can be attached to the ball-joint selector **14** or can be a separate interface positioned within another portion of the user interface **48**. Various touch-screen controls, buttons, dials, and other interfaces can also be incorporated within the selector assembly **10** having the ball-joint selector **14**.

Referring again to FIGS. **1-8**, the selector assembly **10** provides a compact lever-type selector that can be used with shift-by-wire mechanisms **16** in a vehicle setting. It is contemplated that the selector assembly **10** can be used for other components within a vehicle **18** or other mechanical settings as well. In addition, it is contemplated that the selector assembly **10** can be utilized in connection with the shift-by-wire mechanism **16**. The selector assembly **10** can also include an interface that can be used adjust or change parameters of a particular mechanical assembly **12** that the selector assembly **10** controls at that particular time. The selector assembly **10**, in such a configuration, can be used as a singular user interface **48** that can control multiple systems within a vehicle setting or other mechanical setting.

Referring again to FIGS. **4-8**, the ball-joint selector **14** allows the stalk **70** of the ball-joint selector **14** to tilt in fore-aft directions **74** as well as left-right directions **76**. The detent spring **132** and the detent pin **42** cooperate with the detent surface **44** to provide haptic feedback and, in certain situations, auditory feedback as the detent pin **42** engages the various depressions **136** of the detent surface **44** that define the ball-joint selector positions **46**. The ball-joint selector **14** provides for a mechanism where the stalk **70** can be moved in multiple directions, while providing a haptic feedback in each direction that the ball-joint selector **14** is manipulated in. The ball-joint selector **14** includes the spheroid member **32** that is assembled into a cage that is defined by the guide surfaces **24** of the internal supports **22** for the housing **20**. These guide surfaces **24**, as discussed herein, define a spherical cavity **26** that contains the spheroid member **32** of the ball-joint selector **14**. During operation of the ball-joint selector **14**, the spheroid member **32** is contained within the spherical cavity **26** and in alignment with, or substantially in alignment with, the center point **30** of the spherical cavity **26**. Using these components, a ball-joint selector **14** with multi-directional motion can be included within a vehicle setting through a compact interface with the minimal number of component parts.

In certain aspects of the device, the interface between the spheroid member **32** of the ball-joint selector **14** and the spherical cavity **26** of the housing **20** can include one or more friction-reducing materials or interfaces that can be used to provide ease of motion within the ball-joint selector **14** within the housing **20**. These friction-reducing materials and mechanisms can include, but are not limited to, lubricants, bearings, smoothed surfaces, combinations thereof and other similar friction-reducing mechanisms.

As exemplified in FIG. **3**, the first and second pivots **34**, **36** of the ball-joint selector **14** can be used as a positive feedback mechanism when the selector assembly **10** is manufactured and assembled. The positioning of the detent surface **44** receives the detent pin **42** of the ball-joint selector **14**. Also, the first pivot cavity **90** and second pivot cavity **92** receive the first and second pivots **34**, **36**, respectively. The interaction of the first and second pivots **34**, **36** with the first and second pivot cavities **90**, **92** defines a single rotational position of the ball-joint selector **14** within the housing **20**. The same principle can be used where the ball-joint selector **14** includes only one of the first and second pivots **34**, **36** and the corresponding one of the first and second pivot cavities **90**, **92**. This configuration creates a convenient and repeatable assembly mechanism that provides a clear positive feedback when the ball-joint selector **14** is properly positioned in the housing **20** during manufacture. When the housing **20** is assembled, an upper housing portion **150** can be attached with a lower housing portion **152**. The detent surface **44** can be a separate detent portion **154** of the housing **20** that is attached to the lower housing portion **152** to complete the selector cavity **156**. The selector cavity **156** includes each of the spherical cavity **26**, the detent cavity **28** and the first and second pivot cavities **90**, **92**, or only one of each.

According to the various aspects of the device, the ball-joint selector **14** can be made of any one of various rigid materials. Such materials can include, but are not limited to, cast metal, rigid plastic, various polymers, forged metal, combinations thereof, and other similar materials. Where the ball-joint selector **14** is made of plastic, or at least partially made of plastic, the ball-joint selector **14** can be formed utilizing injection molding processes, insert molding processes, and other similar plastic-forming processes that can utilize both plastic and metal components.

According to various aspects of the device, the detent pin **42** can extend from a protrusion defined within a bottom portion of the spheroid member **32**. The detent pin **42** can extend at various distances from the spheroid member **32**, depending upon the configuration of the housing **20** for the selector assembly **10**. It is contemplated that the detent pin **42** can extend from a portion of the spherical surface of the spheroid member **32**, where the detent pin **42** extends from the spheroid member **32** to engage the detent surface **44**. It is also contemplated that the detent pin **42** can be positioned within an integral extension of the ball-joint selector **14** that protrudes from the spheroid member **32** of the ball-joint selector **14**.

According to various aspects of the device, the selector assembly **10** can include various positioning sensors **170** that can be used to monitor the positioning of the ball-joint selector **14** with respect to the detent surface **44** and the various selector positions **46** defined within the selector assembly **10**. These various positioning sensors **170** can be placed in communication with the controller **50** for delivering instructions to the dedicated mechanical assembly **12**, via the controller **50**. As discussed herein, the selector assembly **10** provides a user interface **48** that can communicate certain intentions and instructions from the user, through the user interface **48** and to a particular mechanical assembly **12** within the vehicle **18** or other setting.

According to various aspects of the device, the selector assembly **10** can include a ball-joint selector **14** that includes multiple protrusions. As shown in FIGS. **1-8**, first and second pivots **34**, **36** extend from the spheroid member **32** of the ball-joint selector **14**. It is contemplated that additional anti-rotation features can extend from the spheroid member **32** to further locate and position the ball-joint selector **14** within the housing **20** and prevent rotation about the longitudinal axis **72**. Typically, the spheroid member **32** will include the first and second pivots **34**, **36**. This configuration can provide for a locating mechanism that orients the selector assembly **10** in a particular rotational position with respect to the housing **20**. Accordingly, the ball-joint selector **14** can be located within the housing **20** in a single rotational position that can align various positioning sensors **170** with corresponding receptors that communicate instructions to the respective controller or controllers **50**.

According to various aspects of the device, the portion of the positioning sensor **170** that is included within the spheroid member **32** of the ball-joint selector **14** can be located at various angles with respect to the stalk **70** and the first and second pivots **34**, **36**. In certain instances, the sensor, typically a magnet **164** or other electromagnetic device, can be located along a lateral atmosphere of the spheroid member **32**. In other instances, the sensor can be located along the longitudinal axis **72** of the stalk **70**. Various positions of the sensor therebetween are also contemplated to achieve the desired feedback sensitivity when the ball-joint selector **14** is operated with respect to the spherical cavity **26** and the housing **20**.

According to various aspects of the device, the selector assembly **10** disclosed herein provides a compact lever-type selector that can be placed into a small and confined space and also provides a sufficient level of haptic feedback and sensitivity for achieving the various selector positions **46** with respect to the detent surface **44**. In addition, the compact configuration provides fewer components and a convenient assembly process that achieves repeatability and reliability in the manufacturing process. The configuration of the ball-joint selector **14** with the first and second pivots **34**, **36** can be modified to achieve various shift patterns.

Referring now to FIGS. **1-10**, the housing **20** includes a spherical cavity **26** and a detent cavity **28** that extends outward from the spherical cavity **26**. The housing **20** also includes a sensor cavity **160** that houses and positions the positioning sensor **170**, typically in the form of a Hall sensor **162** proximate the spherical cavity **26**. In this manner, the spherical cavity **26**, the detent cavity **28** and the sensor cavity **160** can define a single continuous selector cavity **156** within the housing **20**. It is contemplated that at least one of the internal supports **22** can be used to separate the sensor cavity **160** from the selector cavity **156**. The ball-joint selector **14** is positioned within the housing **20** and slidably operates within the housing **20** about a center point **30** of the spherical cavity **26**. The ball-joint selector **14** includes a spheroid member **32** that is contained within the spherical cavity **26** and slidably engages the guide surfaces **24** of the spherical cavity **26**. The spheroid member **32** includes a magnet **164** that is in electromagnetic communication with the Hall sensor **162**. The ball-joint selector **14** includes the first and second pivots **34**, **36** that include respective first and second rotational axis **38**, **40** that both extend through the center point **30** of the spherical cavity **26**. The first and second pivots **34**, **36** operate to maintain a rotational position of the ball-joint selector **14** with respect to a longitudinal axis **72** of the stalk **70** for the ball-joint selector **14**. In this manner, the first and second pivots **34**, **36**, according to various aspects of the device, limit the motion of the ball-joint selector **14** to be about the first rotational axis **38** or about the second rotational axis **40**, alternatively. In this configuration, the ball-joint selector **14** can move in a fore-aft direction **74** or in a cross-cabin left-right direction **76**. It is contemplated that certain aspects of the device prevent diagonal motion of the stalk **70** with respect to the spherical cavity **26**.

Referring again to FIGS. **1-10**, the ball-joint selector **14** also includes the detent pin **42** that is biased toward the detent surface **44**. The detent pin **42** slidably engages the detent surface **44** to define the plurality of selector positions **46** of the ball-joint selector **14**. The ball-joint selector **14** and the housing **20** define a user interface **48** that is in communication with the controller **50**. Operation of the ball-joint selector **14** within the spherical cavity **26** and along the detent surface **44** defines the plurality of selector positions **46**. These selector positions **46** are communicated to the controller **50** via the electromagnetic interaction of the magnet **164** and the Hall sensor **162**.

Referring now to FIGS. **4-10**, the Hall sensor **162** positioned within the sensor cavity **160** is positioned near the outer surface **180** of the spheroid member **32** for the ball-joint selector **14**. It is contemplated that the magnet **164** that is contained within the spheroid member **32** can be positioned within a magnet portion **182** of the spheroid member **32**. This magnet portion **182** extends outward from the spheroid member **32**. In this manner, the magnet **164** and the magnet portion **182** extend toward the sensor cavity **160** to define the electromagnetic communication between the magnet **164** and the Hall sensor **162**. In certain aspects of the device, wherein the sensor cavity **160** is continuous with the selector cavity **156**, the magnet portion **182** can extend at least partially into the sensor cavity **160** to define the electromagnetic communication between the magnet **164** and the Hall sensor **162**.

During operation of the ball-joint selector **14** about the first rotational axis **38** and the second rotational axis **40** of the first and second pivots **34**, **36**, respectively, the magnet **164** operates relative to the Hall sensor **162**. As the magnet **164** is moved according to the motion of the ball-joint selector **14**, the magnetic field **184** produced by the magnet **164** is received and sensed by the Hall sensor **162**. The selector positions **46** of the ball-joint selector **14** and the motion of the magnet **164** and the magnetic field **184** as these components operate between the various selector positions **46** are sensed by the Hall sensor **162**. These readings of the Hall sensor **162** are converted into positional information that is communicated to the controller **50**.

It is contemplated that the motion of the magnet **164** with respect to the Hall sensor **162** is configured to coincide with the interaction between the detent pin **42** and the detent surface **44**. Accordingly, as the ball-joint selector **14** is moved into a particular selector position **46**, the interaction between the detent pin **42** and the detent surface **44** provides a haptic feedback. Contemporaneously, interaction between the magnet **164** and the Hall sensor **162** can provide a digital feedback that is communicated to the controller **50** for operating the dedicated mechanical assembly **12** operated by the selector assembly **10**.

According to various aspects of the device, the magnet **164** can be positioned within the various locations of the spheroid member **32**. The magnet portion **182** can be aligned with a hemisphere **210**, typically a lower hemisphere **210**, of the spheroid member **32**. It is also contemplated that each of the magnet portion **182**, the first pivot **34** and the second pivot **36**, can all be positioned along a separate and dedicated hemisphere **210** of the spheroid member **32**. It is also contemplated that the magnet portion **182** can be aligned with the stalk **70** of the spheroid portion. In such a configuration, the detent pin **42** of the ball-joint selector **14** can be positioned at an oblique angle with respect to the stalk **70** for the ball-joint selector **14**. Multiple detents can also be positioned about the magnet portion **182** and about the spheroid member **32** to provide the haptic feedback to the user during operation of the ball-joint selector **14**.

As exemplified in FIGS. **9** and **10**, the magnet portion **182** can be positioned at a 45° angle with respect to either the stalk **70** or the detent pin **42** of the ball-joint selector **14**. Other oblique or angular configurations of the magnet portion **182** are contemplated to provide a sufficient density of the magnetic field **184** with respect to the Hall sensor **162**. A sufficient field density of the magnetic field **184** provides a desirable amount of sensitivity between the magnet **164** and Hall sensor **162** for generating signals based upon the relative positions of the magnet **164** and the Hall sensor **162** as the selector is manipulated about the center point **30** of the spherical cavity **26**.

Referring again to FIGS. **3-8**, as discussed herein, typically, the ball-joint selector **14** operates about the first rotational axis **38** of the first pivot **34** and about the second rotational axis **40** of the second pivot **36**, alternatively. In this manner, the ball-joint selector **14** can move in a fore-aft direction **74** as well as a left-right direction **76**. Typically, diagonal manipulation of the ball-joint selector **14** is prevented based upon the interaction with the first and second pivots **34**, **36** with the first and second pivot cavities **90**, **92**, respectively. During operation of the ball-joint selector **14**, the detent pin **42** can engage various undulations or depressions **136** positioned within the detent surface **44**. These depressions **136** can align along a single concentric area of the detent surface **44** with respect to the home position **120**. The depressions **136** or other surface geometries of the detent surface **44** can also align in an elongated fashion adjacent to a plurality of stable selector positions **46**. Additionally, it is contemplated that the detent surface **44** can include multiple rings or layers of depressions **136** that can provide for successive haptic experiences when the user manipulates the ball-joint selector **14**.

By way of example, and not limitation, a movement of the ball-joint selector **14** away from the home position **120** (or the plurality of stable selector positions **46**) in a particular direction can engage a first level depression **136**. Successive movement of the ball-joint selector **14** beyond the first level depression **136** may engage subsequent levels of depressions **136** that can provide successive haptic feedback to the user as they move the ball-joint selector **14** progressively farther away from the home position **120** or the stable selector positions **46**. Each of these depressions **136** and the positions of the depressions **136** within the detent surface **44** can correspond to a particular relative position of the magnet **164** and the magnetic field **184** with respect to the Hall sensor **162**.

According to various aspects of the device, the Hall sensor **162** can include a sensor location that is a particular distance from the magnet portion **182** when in the home position **120** or the stable selector positions **46**. The orientation of a printed circuit board (PCB) **230** housing the Hall sensor **162** can vary. Accordingly, the PCB **230** can be positioned at an oblique angle, vertically, horizontally, or other direction with respect to the ball-joint selector **14**. In each of these positions of the PCB **230**, the sensor location of the Hall sensor **162** is intended to be a particular distance from the magnet portion **182** of the spheroid member **32** of the ball-joint selector **14**.

According to various aspects of the device, the magnet **164** can be positioned such that the north-south axis **238** of the north pole **240** and south pole **242** of the magnetic field **184** are positioned in a radial orientation with respect to the center point **30** of the spherical cavity **26**. In this manner, the north pole **240** of the magnet **164** is positioned proximate the center point **30** of the spherical cavity **26** and the south pole **242** of the magnet **164** is positioned proximate the sensor location of the Hall sensor **162**, or vice versa. Through this configuration, the magnet **164** can achieve a greater field density such that a smaller magnet **164** may be utilized within the spheroid member **32** of the ball-joint selector **14**.

It is also contemplated that the magnet **164** can be positioned so that the north-south axis **238** of the magnet **164** is positioned in a generally tangential configuration with respect to the outer surface **180** of the spheroid member **32**. Generally, the orientation of the magnet **164** within the spheroid member **32** can vary depending upon the orientation of the magnet portion **182** with respect to the spheroid member **32**. Whether the magnet portion **182** is oblique to the stalk **70** of the ball-joint selector **14** can determine the orientation of the magnet **164**. This orientation of the magnet **164** provides a sufficient field density of the magnetic field **184** emanating from the magnet **164** so that the Hall sensor **162** can sense movements of the magnetic field **184** as the ball-joint selector **14** and the magnet portion **182** are manipulated by the user.

According to various aspects of the device, the ball-joint selector **14** is positioned within the housing **20** to maintain the spheroid member **32** in a consistent position with respect to the spherical cavity **26**. Accordingly, motion of the ball-joint selector **14** operates about the center point **30** of the spherical cavity **26** and is not intended to deviate away from the center point **30** of the spherical cavity **26**. Using the first and second pivots **34**, **36**, which constitute bosses that extend from the spheroid member **32**, rotational motion of the ball-joint selector **14** about the longitudinal axis **72** of the stalk **70** is prevented. By maintaining the rotational position of the spheroid member **32** and the reminder of the ball-joint selector **14** with respect to the center point **30** of the spherical cavity **26**, a consistent and repeatable operable motion of the magnet **164** with respect to the Hall sensor **162** can be achieved. Accordingly, precise readings can be achieved through the interaction between the magnet **164** and the Hall sensor **162**. Through this configuration, the overall size of the selector assembly **10** can be minimized to accommodate a confined space within a passenger cabin of the vehicle **18** or other mechanical assembly **12**.

It is to be understood that variations and modifications can be made on the aforementioned structure without departing from the concepts of the present invention, and further it is to be understood that such concepts are intended to be covered by the following claims unless these claims by their language expressly state otherwise.

What is claimed is:

1. A selector assembly comprising:

a housing having a spherical cavity and a detent cavity that extends outward from the spherical cavity;

a positioning sensor positioned within a sensor cavity of the housing, wherein the positioning sensor is adjacent to the spherical cavity and in communication with the spherical cavity; and

a selector that slidably operates within the housing about a center point of the spherical cavity, the selector comprising:

a spheroid member that is contained within the spherical cavity and slidably engages a guide surface of the housing, wherein the spheroid member includes a magnet that is in electromagnetic communication with the positioning sensor;

a first pivot having a first rotational axis that extends through the center point of the spherical cavity;

a second pivot having a second rotational axis that extends through the center point of the spherical cavity, the second rotational axis being perpendicular to the first rotational axis; and

a detent pin that is biased toward a detent surface of the detent cavity and slidably engages the detent surface to define a plurality of selector positions of the selector, and wherein operation of the selector within the spherical cavity and along the detent surface defines the plurality of selector positions that are communicated to a controller via the magnet and the positioning sensor.

2. The selector assembly of claim **1**, wherein the positioning sensor is a Hall sensor.

3. The selector assembly of claim **1**, wherein the magnet is positioned within a magnet portion of the spheroid member.

4. The selector assembly of claim **3**, wherein the magnet portion extends into the sensor cavity proximate the positioning sensor.

5. The selector assembly of claim **3**, wherein the magnet is positioned within a lower hemisphere of the spheroid member.

6. The selector assembly of claim **1**, wherein the magnet extends outward from the spheroid member.

7. The selector assembly of claim **1**, wherein the magnet is positioned at an oblique angle with respect to a stalk of the selector.

8. The selector assembly of claim **1**, wherein the controller is in communication with a shift-by-wire mechanism and the controller and the shift-by-wire mechanism are in communication with a vehicle transmission.

9. The selector assembly of claim **1**, wherein the selector includes a stalk that extends outward from the housing to define a user interface.

10. The selector assembly of claim **9**, wherein the selector includes a selector body that includes the stalk, the spheroid member and a detent sleeve that houses the detent pin.

11. The selector assembly of claim **10**, wherein the selector body is a single integral piece.

12. The selector assembly of claim **1**, wherein the housing includes a first pivot cavity and a second pivot cavity, wherein the first pivot of the selector extends into the first pivot cavity and the second pivot of the selector extends into the second pivot cavity.

13. The selector assembly of claim **1**, wherein the selector is rotationally fixed with respect to a longitudinal axis that extends through a stalk of the selector, the longitudinal axis being perpendicular to the first rotational axis and the second rotational axis.

14. The selector assembly of claim **1**, wherein the spherical cavity, the detent cavity and the sensor cavity define a single continuous cavity within the housing.

15. A selector assembly comprising:

a housing having a spherical cavity and a detent cavity that extends outward from the spherical cavity;

a Hall sensor that is positioned within a sensor cavity of the housing, wherein the Hall sensor is in communication with the spherical cavity, wherein the sensor cavity and the Hall sensor are positioned outside of the spherical cavity; and

a selector that slidably operates within the housing about a center point of the spherical cavity, the selector comprising:

a selector body that includes a spheroid member, a stalk, a detent sleeve, a first pivot and a second pivot, wherein the spheroid member slidably operates within the spherical cavity and about the center point;

a magnet attached to the spheroid member that is in electromagnetic communication with the Hall sensor; and

a detent pin disposed within the detent sleeve, wherein the detent pin is biased toward and slidably engages a detent surface of the detent cavity to define a plurality of selector positions of the selector, wherein,

operation of the selector within the spherical cavity and along the detent surface defines the plurality of selector positions that are communicated to a controller via the magnet and the Hall sensor;

the selector is rotationally fixed with respect to a longitudinal axis that extends through the stalk; and

the first pivot includes a first rotational axis and the second pivot includes a second rotational axis that is perpendicular to the first rotational axis, the first rotational axis and the second rotational axis extending through the center point.

16. The selector assembly of claim **15**, wherein the magnet extends into the sensor cavity proximate the Hall sensor.

17. The selector assembly of claim **15**, wherein the magnet is positioned within a lower hemisphere of the spheroid member.

18. The selector assembly of claim **15**, wherein the magnet is positioned at an oblique angle with respect to the stalk of the selector.

19. A selector assembly comprising:

a housing having a selector cavity that includes a spherical cavity and a detent cavity; and

a Hall sensor that is positioned within a sensor cavity of the housing, wherein the Hall sensor is in communication with the spherical cavity; and

a selector that slidably operates within the selector cavity about a center point of the spherical cavity, the selector comprising:

a spheroid member that is contained within the spherical cavity and slidably engages a guide surface of the housing, wherein the spheroid member includes a magnet that is in electromagnetic communication with the Hall sensor;

a stalk that extends from the spheroid member and protrudes from the housing;

a first pivot having a first rotational axis that extends through the center point of the spherical cavity;

a second pivot having a second rotational axis that extends through the center point of the spherical cavity, the second rotational axis being perpendicular with respect to the first rotational axis, wherein the selector is rotationally fixed with respect to a longitudinal axis that extends through the stalk, the longitudinal axis being perpendicular to the first rotational axis and the second rotational axis;

a detent sleeve that is integral with the spheroid member; and

a detent pin disposed within the detent sleeve, wherein the detent pin is biased toward and slidably engages a detent surface of the detent cavity to define a plurality of selector positions of the selector, wherein operation of the selector within the spherical cavity and along the detent surface defines the plurality of selector positions that are communicated to a controller via the magnet and the Hall sensor.

20. The selector assembly of claim **19**, wherein the magnet is positioned at an oblique angle with respect to the stalk of the selector.

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